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Contributions to Japanese Characeae.—III.

By T. F. ALLEN.

A.—NEW SPECIES OF NITELLA.

The following Japanese species of *Nitella* seem to belong, properly, to the subdivisions *diarthrodactylae*, *homoeophyllae*, *monoicae*, *subflabellatae*, *congestae*, *microspora*. This group, founded on *N. axillaris* A. Br. (from Caracas, S. Am.), is, in general, characterized by a condensation of the fertile verticils in close spike-like racemes (the new *N. rigida*, *Saitoiana* and *Tanakiana*); or in dense axillary clusters (*N. axillaris* A. Br. and *N. Morongii* Allen).

The group has been divided by Nordstedt into two: (1) With small spores, 290 to 340 long, and (2) With large spores, 400 to 450 long; the capitula of the latter are either terminal or axillary. The species with smaller spores may be arranged as follows (according to size of spore): 250, *N. Morongii* Allen; 275, *N. Saitoiana*; 285, *N. rigida*; 290, *N. axillaris* A. Br.; 306, *N. Tanakiana*; of these *N. rigida* Allen bears fruit in elongated axillar, and terminal spikes; *N. Tanakiana* Allen also, but the spikes are rather like condensed upper verticils; *N. Saitoiana* Allen has more open upper fertile verticils; while *N. Morongii* Allen bears fertile verticils in dense axillary clusters.

NITELLA RIGIDA sp. nov.

Plants erect, strict, almost rigid, 15–20 cm. long; branches strictly erect, not spreading, lower sterile leaves 4 to 6 in a whorl 6–8 cm. long; divided near the apex into 3–5 short branches, which usually are once again divided into two short terminals. From the sterile verticils, long “spikes” of fertile leaves arise, which may exceed the length of the stem; the fertile verticils are at first remote, but become crowded above; the entire “spread” of a fertile verticil is scarcely more than 3 or 4 mm.; the fertile leaves, usually 5 in a whorl, are 2- (rarely 3-) divided; the first segment 54–60 in diam.; the first node bears 5 divisions; the second node carries 2 or 3 terminals; the second segment of the leaf is 45–60 in diam.; the terminals are about 25 in diam., rarely 3-celled and very rarely subdivided; the ultimate cell is a mucro 15 at base by 100 long; the oögonia are single at the node of the leaf, tapered; the oöspore is 285 long by 272 broad, with five rarely six, prominent, sharp ridges; the membrane of the spore is cov-

ered by papillae, not pointed, about $1\ \mu$ long and about three in $5\ \mu$; the antheridia are about 160 in diam., varying with age.

Collected in Shakuhashi pond, Kyoto, Japan.

NITELLA TANAKIANA sp. nov.

Plant 20–25 cm. long, rather simple, sparingly branched; verticils of two sorts quite distinct, lower sterile remote, consisting of six leaves divided near the end into 2 or 4 shorter terminals, 6 or 7 mm. long, which are often again subdivided; the terminals are, as a rule, 3-celled, the ultimate cell a mucro; the upper fertile leaves are very short, and at the upper part of the stem the verticils become gradually smaller and closer or elongated shoots arise from the lower sterile verticils and bear only close whorls of fertile leaves (having the appearance of spikes); the fertile leaves are 2-divided (very rarely, a third division has been seen); the *first node* consists of 3 or 4 divisions, the second of 2 or 3 (rarely 4) unequal terminals; the terminals are 3-celled (with only an occasional exception) the first cell *two-thirds the length of the entire terminal*, the second cell tapering somewhat to the third which is a mucro; the stem is about $333\ \mu$ in diam.; the first segment of a leaf 130, the second 116 to 58, the third 75 tapering to 50, the mucro, almost triangular, 30 to 45 at base and 80 to 116 long; the mucro drops easily and early; mature leaves are rarely found with mucrones.

The species is monoecious; oogonia occur on both nodes of the leaf, often aggregated. The oöspore is 306 long by 272 broad, with 6 (or 7) sharp and prominent ridges. The membrane is characterized by granulo-reticulate markings, small pointed granules are arranged in reticulated series with a faint connecting line, and with larger granules at the junction of the irregularly hexagonal reticula.

The relationship of this interesting species seems clearly to be in the group with *N. rigida* Allen, from which it differs by its more flexible habit, the character of the terminals and of the oöspores.

This plant was collected in Hirosawa pond, Kyoto, Japan.

NITELLA SAITOIANA sp. nov.

Plants 15–20 cm. long, somewhat branched, with numerous whorls of long leaves which become crowded and abbreviated above. In the lower part of the stem the verticils are 3–4 cm. distant, the leaves about 3 cm. long, equaling the length of the internode. The lower leaves are sterile and divided above the middle into 3 or 4 segments, which are again divided (usually) into 2 or 3 very short mucronate terminals. The leaves

of the upper verticils are shorter but still diffusely spreading and not condensed into a congested mass; they are 2-, rarely 3-divided; the *first node* bears 3-5 divisions and is at times fertile, the *second* 2 or 3, and the *third*, when present 2 (rarely 3 terminals). The stem is 400 in diameter, the verticil consists of 7 or 8 leaves; the first segment of the leaf is 286 in diameter, the second 200, the third 143 and the terminal 143. The terminal is frequently 3-celled, the division being $\frac{3}{4}$ near the upper extremity; it does not taper markedly to the mucro. The mucro is about 25-35 in diameter to 70-80 long, not very evanescent. The antheridia are about 225 in diameter. The oögonia are isolated usually, but often aggregated at both nodes, more often on the second node. The oöspores are 275 long by 240 broad, with five or six ridges; the membrane is marked by long and short granules irregularly arranged.

This species seems to belong in a group with *Nitella rigida* and *N. Tanakiana*, and to be slightly related to *N. gracilis*; from the former species it is distinguished by its more diffuse habit, the fertile verticils not on spike-like shoots, from *N. gracilis* by numerous characters, though the tendency to the *three-celled* terminal is seen in all these species.

Collected in Sweibachi-ike pond, province Kyoto, Japan. Named for a faithful and industrious collector, Kenzo Saito.

B.—NOTE CONCERNING NITELLA ORIENTALIS ALLEN, WITH DESCRIPTION OF A NEW ALLIED SPECIES.

NITELLA ORIENTALIS Allen, Bull. Torr. Bot. Club, 21: 524. 1893.

This plant varies greatly from different localities, not only in size, but in the divisions of the leaves. The leaves are often only 3 times divided, often 5 times; the terminals, often very short (brachydactylae) are again quite long (macroductylae), so that I have been in doubt about referring the species to the "*polyglochin*" series. The antheridia vary from 75-300 in diameter. The oögonia are usually clustered, but sometimes isolated *never on the first node*; the oöspores vary from 340-375 long and 285-320 broad, always with 7-9 ridges. The surface of the spore seems to have a superficial and dense grumous layer of felted fibres, covering a granulated surface, but the granules are not pointed and do not protrude through the felted layer.

This species seems to me to belong rather to the *macroductylae* division, and to be allied to my new *N. expansa*, to which its

similar habit of growth associates it. Formerly, owing to the very unequal and extremely abbreviated terminals, I referred it to the *brachydactylae* section with which it seems ill-assorted.

N. orientalis and *N. expansa* are similar to *N. gracilis* in habit of growth, but the oögonia are clustered and the oöspores differ. The divisions of the leaf and the character of the terminals also separate these two species. The tendency to abbreviated terminals and to more than three leaf-nodes in *N. orientalis* points to a sort of transition to the species of the *brachydactylae* series (which abound in Japan).

NITELLA EXPANSA sp. nov.

Plants 10–12 cm. high, diffusely branched, “bushy;” leaves spreading, diffuse, stem 450 in diam; verticils approximate, of 5 or 6 leaves; leaves spreading, often longer than the internodes, 3 (rarely 4) times divided; the first segment less than half the length of the entire leaf, 200–265 in diam; the first node, with 5 or 6 divisions, usually sterile; the second segment 160–170 in diam; the second node, *with three divisions*, fertile; the third segment 145–155 in diameter; the third node, with 2 or 3 divisions, fertile; the fourth segment, 100–120 in diam., usually terminal. The mucro, 34 in diam., 80–100 long; the terminals are unequal, 1–3, often very short; the oögonia are usually isolated, but often aggregated on the second and third nodes, *not seen on the first node, but often found in the verticil, on the stem*. The antheridia about 200 in diameter; the oöspore 245 to 250 long by 204 to 220 broad, with five or six sharp ridges, at second and third nodes, the surface *quite smooth*.

In its aspect it is quite similar to *N. gracilis*; the first node of the leaf also bears four divisions and is sterile. It is similar to *N. orientalis* in the unequal terminals, one of which is often very short, but the second node of this species is 3-times divided and the oöspore is smaller with a smooth surface (granular in *N. orientalis*).

Collected in “Shakuhachi-bori water,” Kyoto, Japan.

G.—DESCRIPTION OF A NEW JAPANESE NITELLA ALLIED TO OUR AMERICAN SPECIES, *N. TRANSILIS* ALLEN, AND *N. TENUISSIMA* DESV.

NITELLA GRACILLIMA sp. nov.

Plants very delicate; 6 to 8 cm. high; branched, but not diffusely; branches and leaves mostly rather erect, not spreading; stem 80 to 90 μ diam.; verticils consist of 6 leaves; leaves somewhat erect, not diverging from the stem, not quite equal to the

internode (aspect of *N. transilis* Allen); leaf usually thrice divided; the *first segment* nearly half the length of the entire leaf; 54–60 in diam.; *first node* has 6–7 divisions; sterile; the *second segment*, shorter, 40 to 48 in diam.; the *second node* bears four divisions, fertile; the third segment, 30 to 35 in diam.; the third node, fertile, bears 4 or even 5 terminals; the terminals slender, longer than the preceding segment and nearly as long as the first, 34 in diameter, one-celled, except the mucro, which is about 15 in diameter by 55 to 68 long (large for the size of the plant).

The oogonia are isolated at the second and third nodes of the leaf; the oöspore is 190 to 197 long by 150 to 156 broad, with six or seven sharp wavy ridges. Antheridium 125 to 135 in diam. The *spore membrane is remarkable in being covered with coarse elevated elongated granules*. The ridges are acute at their tops, but spread at their bases, where they join the surface of the shell; these bases are wavy-toothed. The granules are often very short, almost oval, often elongated even to a length of five mikrons.

This species approaches *N. transilis* Allen, differing in its greater tenuity, *much smaller oöspore*, with a different spore-membrane.

Collected in "Shinbashi water" province of Mikawa, Japan; mature in December.

D.—DESCRIPTION OF NEW VARIETIES AND FORMS OF NITELLA PSEUDOFLEBELLATA A. BR. FROM JAPANESE WATERS.

The name was given by A. Braun to the species collected by the Prussian expedition to eastern Asia, 1866. This was formerly confused with *N. flagelliformis* (*N. dispersa* A. Br.) from Java, in Lake Telaga Padenga (in Herb Van den Bosch) very elongated, one to two feet, relatively slender, verticils remote with condensed and tangled leaf-tips, so differing from *N. gracilis*, also blackish-green, flexible. * * * Fertile leaves three- or even four times divided. *The first segment of the leaf distinguished by its length, as long as, or longer than all the divided part of the leaf*. First division into five or six rays, of which one or two may be simple, the remainder further divided; the succeeding segments becoming shorter, but the last again longer. * * * Java: China: Bengal: Borneo, var. *mutila* A. Br.

In his Characeae Nov. Zeland. in Act. Univ. Lund, 1880, Nordstedt publishes a description of a *forma mucosa* and considers it a possible new species.

The elongated first member of the leaf is taken to be a feature of this species ; it determines the peculiar aspect of the plant when growing and is quite unique.

NITELLA PSEUDOFABELLATA IMPERIALIS var. nov.

Plants 20–25 cm. long ; stems usually simple, 540 μ in diam. Verticils remote (in the middle portions, 3–4 cm. distant), 12–15 mm. in diam. Leaves 5–8 mm. long : *first segment longest (longer than half of the entire leaf)*, about 220 μ in diam. : second segment 102 in diam., about 1200 μ long ; third segment 68 in diam., 540 μ long ; fourth segment 54 in diam., about 600 long (if divided), when the fifth seg. becomes terminal it is about 800 long. The leaf bears three, and frequently four nodes, the *first is sterile usually*, and bears 6–8 rays ; the *second* node, fertile, bears 4–5 rays, some of which may be undivided. The *third* node, also fertile, carries 4 or 5 rays, and these are frequently again divided, this *fourth* node bearing three (usually) terminals. The mucro is pronounced, about 27 in diam. at base, by 82–102 long. *Fruit mostly on the second and third nodes (not seen on the first or last nodes) ; oögonia isolated*, oöspore black, with seven or eight pronounced ridges, 326 long, 272 broad. Membrane covered with a fine close felt of fine hairs.

The membrane of the spore is most similar to the specimens from Hong Kong, and differ from those from Australia, New Zealand and Java by not having, in addition to the “felt,” short spines. In the size of the spores and the character of the membrane it cannot be separated from the Chinese form. These plants from Japan seem to be covered with mucus, which, when dried, causes a glistening appearance to the specimens and glues them tightly to the paper. Collected in Mishitani pond, Fujisato village, prov. Ise, Japan, in September.

While the similarity in the oöspore connects this form with the Chinese form, the Japanese plant is strikingly different in its general habit, and following the advice of Nordstedt I give it a distinct varietal name *imperialis*.

NITELLA PSEUDOFABELLATA RAMUSCULA var. nov.

Plants about 15 cm. long, diffusely branched, slender, about 400 μ in diam. Verticils often crowded (the leaves exceeding the length of the internodes), consisting of 8 leaves. The leaves are 5–8 mm. in length ; *the first segment longer than half the length of the leaf*, 175–220 in diam. The leaf is usually thrice divided ;

the *first node sterile*, bears 6-7 rays; the *second, fertile*, bears 5 rays; the *third node, sterile*, bears 2-4 simple, two-celled, terminal rays. *In fertile leaves these terminals are again divided, but rarely.* The *second segment* is shorter than the first, 75-80 in diam.; the third is about the length of the second, 48 in diam. Occasionally a ray of the second, fertile, node is undivided and elongated to equal the length of the terminal rays. The mucro is 20 in diam. at base and 70-80 long. The antheridium is about 125 in diam. *The oogonia are isolated at the second node, only*; the oospore 292 long by 272 broad; with 7-8 faint ridges. The surface of the colored membrane is marked by faint granules, in very low relief, the tops of the ridges are dotted with more prominent granules irregularly disposed, almost as if toothed. From the type this variety differs in its more diffuse habit, the *size of the oospore and by the markings on its surface.*

The plant was gathered in Shakuichi pond, Kyoto, Japan.

NITELLA PSEUDOFLLABELLATA RAMUSCULA Allen *forma testa-glabra.*

Plants about 30 cm. long, slender, lower verticils remote upper becoming crowded, sparingly branched, stem about 500 μ in diameter. The verticils consist of 8 leaves. The leaves are thrice divided (very rarely four times divided). The first segments of the leaves are quite long, *about four-fifths of the entire leaf*, 150 in diam. *The first node is sterile*, and consists of 6 or 7 divisions; the *second node, fertile*, has four (usually, rarely 6) divisions, with an occasional undivided terminal ray; the *third node, sterile*, bears three to four terminals. The second segment of the leaf is usually short, 80 in diameter, the third segment is longer than the second about 54 in diameter; the fourth (and fifth, when present) are terminal, 50 in diameter, tapering to the end; the mucro 20 μ in diameter and 60 long. The antheridia are about 136 in diameter; *the oogonia isolated on the second node only.* The oöspores are 285 long by 272 broad with six faint ridges; the colored membrane of the oöspore is *perfectly smooth.* No indications of mucus have been found on either of the forms in this variety.

Gathered in Mizoro pond, Kyoto, Japan.

E.—A NEW DIVISION OF THE FLABELLATAE-MACRODACTYLAE SPECIES OF THE DIARTHRODACTYLAE SECTION OF NITELLA.

The species now known, have been classified as (1) *Subflabellatae*, leaves once or twice divided, and (2) *Flabellatae*, twice, thrice or even four times divided. While these divisions cannot be sharply defined, they have served to embrace our known species

and furnish places for many new ones; but a few new forms have come to hand with *leaves many times divided*, with more than four or even six nodes, and it would be convenient to enlarge the bounds to admit them. They cannot be referred to the *brachydactylae* group for they belong to the *macroductylae*. They do not consort with the forms of *N. pseudoflabellata* A.Br., for the leaves differ in appearance, especially because the first segment of the leaf is not longer than half of the whole divided leaf; so I propose a new subdivision, *Perflabellatae*, with *leaves 4 or more times divided*. The new arrangement is as follows:

1. *Segments of the second division of the leaf, commonly 2 or 3; primary segments not longer than half the divided leaf* (*N. mucronata* A. Br., *N. expansa* Allen, etc.). § 1. FLABELLATAE.

2. *Secondary segments commonly 4-6; primary segments longer than half the divided leaf* (*N. pseudoflabellata* A. Br. and varieties). § 2. PSEUDOFABELLATAE.

3. *Secondary segments commonly 4-5; primary segments not longer than half the leaf. Leaf many times divided with 4-6 or more nodes*. § 3. PERFLABELLATAE.

Since the forms of the last section are somewhat similar in habit, have a similar oöspore-membrane, and the first node is usually *sterile* and the *ögonia isolated*, I have placed them under one species, with three varieties as follows:

NITELLA MULTIPARTITA sp. nov.

Plants elongated, 40 cm. or more, flexible, branching from nearly every verticil. *Verticils* somewhat remote (at centre of stem) of 6-8 leaves which spread from stem. *Leaves* about 2 cm. long. First segment *almost*, but not quite, half the combined length of all the divisions of the leaf; divided *four* or even *six* times; *first node*, bears 6 to 7 segments, *sterile*; second *node*, *fertile*, bears 4 or 5 segments; *third node*, *sterile* or *fertile*, bears 4 segments; *fourth node*, bears 4 segments; *fifth node*, bears 3 segments; *sixth node*, bears 2 or 3 terminals. The mucro is 30 μ in diameter, by 54 long. *The first node is always sterile. The ögonia are isolated* at the second node, rarely also on the third node. The oöspores are 275 to 300 μ long, and 240 to 290 broad, with 7 or 8 rounded ridges; the membrane is evenly granular with about three granules in 5 mikrons.

Collected in "Obitorinoike water," Kyoto, Japan. Mature in July.

The following forms coincide with the type in having leaves with 4 to 6 nodes; the *first node always sterile*; the oögonia isolated at the second and third nodes and the spore-membrane granular.

As regards division of the leaf, the type has six nodes: *f. suberecta* and *f. intermedia* have each five and *f. transiliforma* four. In respect to size the type is more spreading and longer, *f. intermedia* is coarser and *f. transiliforma* the most delicate; as to oöspores *f. intermedia* reaches 306 μ long by 218 broad, while the others vary within the limits of 240 to 300 long by 224 to 290 broad; the granulation of the spore-membrane is tolerably uniform in all, but faintest in *f. suberecta*.

The mucrones vary from 48 by 15 *intermedia*; 61 by 27 in *suberecta*, 54 by 30 in the type and *f. transiliforma*.

NITELLA MULTIPARTITA Allen, *forma suberecta*.

Plants 15–20 cm. long, rather erect, sparingly branched; stem about 400–500 in diam. *Verticils* spreading, color dull yellowish green, more of the aspect of the forms of *N. pseudoflabellata* than of the bright, clear green of the succeeding form. Leaves bear, 4 or 5 nodes; *first*, with 6 or 7 divisions, *sterile*; *second*, 4 or 5 divisions fertile; *third*, 4 or 5 divisions, fertile; *fourth*, 3 or 4 divisions, sterile; *fifth* node with 2 or 3 divisions. The segments of the leaves vary, the *first* 2800–3300 long, 122 in diam., the *second* 1600–2600 long, 48–80 in diam.; the *third* 1400–2700 long, 54 in diam.; the *fourth* 500–2000 long, 40 in diam.; the terminals 170–240 long, 34 in diam.; the mucro 20–25 in diam. at base by 50–68 long. The oögonia are isolated; the oöspore 272 long by 245 broad, with seven faint striae, faintly granular.

Collected in Mizoro pond, Kyoto, Japan, in July.

NITELLA MULTIPARTITA Allen, *forma transiliforma*.

Plants about 20 cm. long, erect with about six verticils of bright green leaves. Verticils do not overlap; stem-nodes about 30–40 mm. distant, leaves about 25 mm. long. Stem sparingly branched, as a rule only near the base; stem and branches erect. Leaves slightly spreading, somewhat erect, forming a close verticil about the stem. Stem 400–500 in diameter. Verticil consists of 7 leaves. Leaves 3–4 divided; *first* node 6–7 divisions, *second* 3–4 divisions, *third* 2–3 divisions, *fourth* (when present) 2–3 divisions. The *first segment, less than half the length* of the leaf, 105 in diameter, the *second* 75, the *third* 50, the fourth terminal, 40

in diameter. The mucro 30 in diameter. The mucro 30 in diameter, by 54 long. The oögonia are *isolated* on the *second node only*. Antheridia not seen (plants mature and very fertile); oöspores 275–300 long by 240 broad with 7–8 blunt ridges: membrane of the spore evenly granular (about 3 granules in 5 μ).

This form, it seems, cannot be separated specifically, though it is an apparent transitory form to *N. transilis* Allen. Like the latter species the leaves are sometimes only 3-divided, and it more resembles *N. transilis* in its fresh, bright green color with close, erect verticils than extreme forms of the type, with a flexuous prostrate habit, of a dull yellowish or brownish green color, with spreading verticils; but the character of the spores, the numerous transition forms and its locality connect it with *N. multipartita*.

The plants were collected in the same locality as the *f. intermedia*.

NITELLA MULTIPARTITA Allen, *forma intermedia*.

This form differs from the type in its more erect habit with less spreading verticils, fewer nodes on the leaves (4 or very rarely, 5); the plants are more slender though more erect, the diameters being as follows: *First* segment 306, *second* 140, *third* 82, *fourth* 61, *fifth* 48; the mucro 15 by 48. The oöspores are of the same size with the same character of ridges and sculpturings on their membranes.

Collected in Kyoto, Japan.

NOTE.—A number of etchings are being made to distribute with the separately printed copies; these will be sent cheerfully to all who may be specially interested in Characeae. T. F. Allen, 3 East 48th Street, New York City.